

Application No. 09/964,227

Applicants respectfully request re-examination, reconsideration and allowance of each of pending claims 1-19, 27 and 28.

I. Allowable Subject Matter

In the Office action, specifically on page 6, claims 11 and 14 were objected to as being dependent upon a rejected base claim, and the Examiner indicated that claims 11 and 14 would be allowable if rewritten in independent form, including all of the limitations of the base claim and any intervening claims.

The limitations of previously pending claim 11 have been combined with the limitations of previously pending base claim 1 and intervening claim 10, from which claim 11 had previously depended, to produce newly added claim 27.

The limitations of previously pending claim 14 and previously pending base claim 1, from which claim 14 previously depended, have also been combined to produce newly added claim 28.

Since newly added claim 27 represents objected-to claim 11 rewritten in independent form to include the features of previously pending claims 1 and 10, newly added claim 27 is in allowable form. Similarly, since newly added independent claim 28 represents objected-to claim 14 rewritten in independent form, claim 28 is also in allowable form.

Each of claims 10, 11 and 14 has also been retained to depend, directly or indirectly, from independent claim 1, which has been amended as set forth below.

II. Claim Rejections Under 35 U.S.C. § 102(b)

In the Office action, more particularly on page 2, third paragraph, claims 1-3, 15-16 and 19 were rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,904,575 ("Ishida"). Applicants respectfully submit that these claim rejections are overcome based on the claim amendments and the remarks set forth below.

Independent claim 1 has been amended to recite the features of:

“introducing nitrogen into at least one of said N-doped regions to form at least one capacitor region; and forming a capacitor by forming a top capacitor plate over each capacitor region.”

Applicants respectfully submit that Ishida does not disclose a capacitor or a capacitor plate as recited in amended independent claim 1. In fact, applicants respectfully submit that the terms “capacitor plate”, “electrode” or “capacitor” do not appear in Ishida. Applicants further submit that Ishida does not suggest the formation of a capacitor. Furthermore, while Ishida recites EEPROMS, applicants respectfully submit that it is not the case, much less inherent, that all EEPROMS have capacitors formed within dopant areas, within dopant areas that include nitrogen therein, within dopant areas that include a relatively thin oxide, or over program junction areas.

As such, Ishida neither discloses nor suggests the steps of forming a capacitor region and forming a capacitor by forming a top capacitor plate, much less forming the capacitor region by introducing nitrogen into an N-doped region, and since forming capacitors in the particular doped regions (as above) is not inherent in all EEPROMS, amended independent claim 1 is distinguished from Ishida, and the rejection of claim 1 under 35 U.S.C. § 102(b), as being anticipated by Ishida, should be withdrawn. Claim 2 has been amended for consistency with the amendments to claim 1, from which claim 2 depends. Claims 2-3 and 15-16 each depend from amended independent claim 1 and are therefore also distinguished from the Ishida reference. As such, the rejection of claims 2-3, 15 and 16 under 35 U.S.C. § 102(b), as being anticipated by Ishida, should also be withdrawn.

Claim 19, previously an independent claim, has been amended and now depends from newly added claim 28, which is allowable for reasons set forth above. Claim 19 is therefore also allowable, and the rejection of claim 19 under 35 U.S.C. § 102(b), as being anticipated by Ishida, should therefore be withdrawn.

III. Rejection of Claims 1-3, 5, 7, 9, 13, 15-16 and 18-19 Under 35 U.S.C. § 103(a)

In the Office action, particularly on page 3, last paragraph, claims 1-3, 5, 7, 9, 13, 15-16 and 18-19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ishida in view of U.S. Patent No. 5,854,114 ("Li"). Applicants respectfully submit that these claim rejections are obviated based on the claim amendments and remarks set forth below.

Of the above-listed claims, only amended claim 1 is an independent claim after the present amendments. Claims 2, 3, 5, 7, 9, 13, 15, 16 and 18 each depend, directly or indirectly, from amended independent claim 1. Amended independent claim 1 is distinguished from Ishida for reasons set forth above.

The cited reference of Li has apparently been relied upon for disclosing a PRJ implant of phosphorous with a dose of about 1×10^{14} to 1×10^{16} ions/cm² and an energy of 50-100 KeV. Li therefore does not make up for the above-stated deficiencies of Ishida. The Examiner also states that "claims 9 and 18 are met by the tunneling oxides grown simultaneously with the thin tunneling oxide 154 in (relatively) undoped portions of the substrate (FIGS. 3I-3m)", subject Office action, page 4, lines 11-12.

Amended independent claim 1 recites features directed to forming a capacitor (as above) and claims 2, 3, 5, 7, 9, 13, 15, 16 and 18 therefore also incorporate the distinguishing features of amended independent claim 1. Since the cited reference of Li and the Examiner's statement (recited above) do not make up for the above-stated deficiencies of Ishida, each of claims 1-3, 5, 7, 9, 13, 15-16 and 18 are distinguished from the references of Ishida and Li, taken alone or in combination, and the rejection of claims 1-3, 5, 7, 9, 13, 15-16 and 18 under 35 U.S.C. § 103(a), as being unpatentable over Ishida in view of Li, should be withdrawn.

As stated above, previously-independent claim 19 has been amended and now depends from newly added claim 28, which is in allowable form for reasons set forth above.

Therefore, the rejection of claim 19 under 35 U.S.C. § 103(a), as being unpatentable over Ishida in view of Li, should also be withdrawn.

IV. R ejection of Claims 1-3, 5, 6, 12, 17, 15-16, and 19 Under 35 U.S.C. § 103(a)

In the Office action, particularly on page 4, fifth paragraph, claims 1-3, 5, 6, 12, 17, 15-16, and 19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ishida in view of U.S. Patent No. 5,750,428 ("Chang"). Applicants respectfully submit that these claim rejections are obviated based on the remarks set forth below.

Of the above-listed claims, only amended claim 1 is an independent claim after the present amendments. Claims 2, 3, 5, 6, 12, 17, 15 and 16 now each depend, directly or indirectly, from amended independent claim 1. Amended independent claim 1 is distinguished from Ishida for reasons set forth above. Claim 17 has been amended to now depend from amended independent claim 1.

The cited reference of Chang has apparently been relied upon for teaching a tunnel oxide having a thickness of less than 55 angstroms and a gate oxide of 150 angstroms. The Examiner also states that Ishida teaches an oxidizing temperature of 900°C and concedes that Ishida does not teach the time of 5 to 15 minutes. The Examiner further states "Since these parameters together determine an oxide thickness that is met by Ishida, the temperature is obvious in view of Ishida", subject Office action, page 5, lines 7-8, referring to the temperatures recited in claim 12.

The cited reference of Chang does not provide a capacitor and therefore the cited reference of Chang and the Examiner's statement (recited above) do not make up for the above-stated deficiencies of Ishida. As such, claims 1-3, 5, 6, 12, 17, 15 and 16 are distinguished from the references of Ishida and Chang, taken alone or in combination. Therefore, the rejection of claims 1-3, 5, 6, 12, 17, 15 and 16, as being unpatentable over Ishida in view of Chang, should be withdrawn.

Claim 19 has been rewritten to depend from allowable claim 28, and therefore the rejection of claim 19 under 35 U.S.C. § 103(a), as being unpatentable over Ishida in view of Chang, should also be withdrawn.

V. R ejection of Claims 1-4, 8, 10, 15-16 and 19 Under 35 U.S.C. § 103(a)

In the Office action, specifically on page 5, third paragraph, claims 1-4, 8, 10, 15-16 and 19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ishida in view of U.S. Patent No. 5,942,780 ("Barsan"). Applicants respectfully submit that these claim rejections are obviated based on the remarks set forth below.

Of the above-listed claims, only amended claim 1 is an independent claim after the present amendments. Claims 2-4, 8, 10, and 15-16 each depend, directly or indirectly, from amended independent claim 1. Amended independent claim 1 is distinguished from Ishida for reasons set forth above. Claims 2, 8 and 10 have been amended for consistency with the amendment to independent claim 1.

The cited reference of Barsan teaches a nitrogen implant dose of $15 \times 10^{14}/\text{cm}^2$ at a range of 29-32 KeV. Barsan also teaches using a photoresist to mask a nitrogen implant for the purpose of suppressing oxide growth in an EPROM device. Barsan, however, does not teach the following features that appear in amended independent claim 1:

"introducing nitrogen into at least one of said N-doped regions to form at least one capacitor region; and
thermally oxidizing said substrate surface to form an oxide film on said semiconductor surface, said oxide film having a first thickness in said at least one capacitor region and a *second thickness being greater than said first thickness in other portions of said N-doped regions*".

Barsan does not teach or suggest the N-doped region having a second thickness greater than a first thickness in a nitrogen-doped region. Amended independent claim 1 therefore includes features neither taught nor suggested by the references of Ishida and Barsan, taken alone or in combination. Claim 1 is therefore distinguished from the references of Ishida and Barsan, and since claims 2-4, 8, 10, 15 and 16 each depend, directly or indirectly, from amended independent claim 1, claims 2-4, 8, 10, 15 and 16 are also distinguished from the combination of Ishida and Barsan, and the rejection of claims 1-4, 8, 10, 15 and 16 under 35 U.S.C. § 103(a), as being unpatentable over Ishida in view of Barsan, should be withdrawn.

Claim 19 has been amended and now depends from allowable claim 28. The rejection of claim 19 under 35 U.S.C. § 103(a), as being unpatentable over Ishida in view of Barsan, should therefore also be withdrawn.

VI. Claims 20-26

Claims 20-26 were previously withdrawn from consideration and are hereby canceled.

VII. Claims 11 and 14

Originally-objected-to claims 11 and 14 are retained and depend from amended independent claim 1, which is allowable for reasons set forth above. More particularly, amended claim 11 depends from amended claim 10, which depends from amended independent claim 1; and claim 14 depends directly from amended independent claim 1. Each of claims 10 and 11 has been amended for consistency with the amendments to independent claim 1. Since claim 1 is now in allowable form, each of dependent claims 11 and 14 is therefore also in allowable form.

CONCLUSION

For the foregoing reasons, each of pending claims 1-19, 27 and 28 is in allowable form, and the application is therefore in condition for allowance, which action is respectfully and expeditiously requested.

Attached hereto is a marked-up version of the changes made to the above-identified application by the current amendment. The attached page is captioned "Version with markings to show changes made."

Respectfully submitted,
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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Amend claims 1, 2, 8, 10, 11, 17 and 19 as indicated.

1. (Amended) A process for forming a semiconductor product, comprising the steps of:

providing a semiconductor substrate having a semiconductor surface;

introducing N-type dopant impurities into said semiconductor surface, thereby forming N-doped regions within said semiconductor surface;

introducing nitrogen into at least one of said N-doped regions to form at least one capacitor [nitrogen] region; and,

thermally oxidizing said substrate surface to form an oxide film on said semiconductor surface, said oxide film having a first thickness in said at least one capacitor [nitrogen] region and a second thickness being greater than said first thickness in other portions of said N-doped regions; and

forming a capacitor by forming a top capacitor plate over each capacitor region.

2. (Amended) The process as in claim 1, in which said ~~semiconductor product is a Metal Oxide Semiconductor (MOS) capacitor and in which each nitrogen region forms a capacitor region and further comprising~~ forming a top capacitor plate comprises forming ~~comprising~~ one of a conductive material and a semiconductor material ~~over each capacitor region, after said step of thermally oxidizing~~.

8. (Amended) The process as in claim 1, in which said [nitrogen] capacitor region includes a nitrogen density within the range of 10^{17} to $10^{19}/\text{cm}^3$.

10. (Amended) The process as in claim 1, further comprising the step of defining said at least one capacitor [nitrogen] region prior to said step of introducing nitrogen, said defining comprising forming a masking pattern in a photosensitive material.

11. (Amended) The process as in claim 10, in which said masking pattern includes each capacitor [nitrogen] region forming a lower capacitor electrode, having a rectangular shape and including sides ranging from 2 to 100 microns in length.

17. (Amended) The [A] process as in claim 1, wherein said [for forming a thermal oxide film having multiple thicknesses, comprising the steps of:

~~providing a silicon substrate having a silicon surface;~~
~~forming a plurality of dopant impurity regions in said silicon surface, said dopant impurity regions formed of one of phosphorous and arsenic;~~
~~implanting nitrogen into a nitrogen portion of at least one of said dopant impurity regions; and]~~

~~thermally oxidizing comprises forming [said substrate to form an oxide film thereover,]~~
~~said oxide film such that [having a first thickness in said nitrogen portions and a second thickness in other portions of said dopant impurity regions,] said second thickness is [being]~~
greater than said first thickness by at least 80%.

19. (Amended) The [A] process as in claim 28, wherein said semiconductor product comprises [for forming] a Metal Oxide Semiconductor (MOS) capacitor, [comprising the steps of:

~~providing a silicon substrate having a silicon surface;~~
~~introducing N-type dopant impurities into said silicon surface, thereby forming N-doped regions within said silicon surface;~~
~~implanting nitrogen into at least one of said N-doped regions to form at least one capacitor region;~~
~~thermally oxidizing said substrate to form an oxide film on said silicon surface, said oxide film having a first thickness in said at least one capacitor region and a second thickness being greater than said first thickness in other portions of said N-doped regions; and,]~~

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and further comprising forming a top capacitor plate of at least one of a conductive material and a semiconductor material over said at least one nitrogen [capacitor] region.

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